INTRODUCTION:

Cardiac computed tomography (Heart CT) can be used to image the cardiac chambers, valves, myocardium and pericardium to assess cardiac structure and function. Applications of Heart CT listed and discussed in this guideline include: characterization of congenital heart disease, characterization of cardiac masses, diagnosis of pericardial diseases, and pre-operative coronary vein mapping.

The table below correlates and matches the clinical indications with the Appropriate Use Score based on a scale of 4 to 9, where the upper range (7 to 9) implies that the test is generally acceptable and is a reasonable approach. The mid-range (4 to 6) indicates uncertainty in the appropriateness of the test for the clinical scenario. In all cases, additional factors should be taken into account including but not limited to cost of test, impact of the image on clinical decision making when combined with clinical judgment and risks, such as radiation exposure and contrast adverse effects, should be considered.

Where the Heart CT is the preferred test based upon the indication the Appropriate Use Score will be in the upper range such as noted with indication #29, assessment of right ventricular morphology or suspected arrhythmogenic right ventricular dysplasia.

For indications in which there are one or more alternative tests appropriate use score rating (appropriate, uncertain) noted, for example indication #30 Assessment of myocardial viability, prior to myocardial revascularization for ischemic left ventricular systolic dysfunction and other imaging modalities are inadequate or contraindicated, additional factors should be considered when determining the preferred test (Stress Echocardiogram if there are no contra-indications).

Where indicated as alternative tests, TTE (transthoracic echocardiography) and SE (Stress echocardiography) are a better choice, where possible, because of avoidance of radiation exposure. Heart MRI can be considered as an alternative, especially in young patients, where recurrent examinations may be necessary.
**INDICATIONS FOR HEART CT:**

- To qualify for cardiac computed tomography, the patient must meet ACCF/ASNC Appropriateness Use Score (Appropriate Use Score 7 – 9 or Uncertain Appropriate Use Score 4-6).

**ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate Use Criteria for Cardiac (Heart) Computed Tomography:**

<table>
<thead>
<tr>
<th>ACCF et al. Criteria #</th>
<th>Heart CT (Indication and Appropriate Use Score)</th>
<th>INDICATIONS (*Refer to Additional Information section)</th>
<th>Other imaging modality crosswalk, TTE, Stress Echo (SE) and Heart MRI (ACCF et al. Criteria # Indication with Appropriate Use Score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of Cardiac Structure and Function</td>
<td></td>
<td></td>
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<tr>
<td><strong>Adult Congenital Heart Disease</strong></td>
<td></td>
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<tr>
<td>25 A (9)</td>
<td>• Assessment of anomalies of coronary arterial and other thoracic arteriovenous vessels* (*for “anomalies of coronary arterial vessels” CCTA preferred and for “other thoracic arteriovenous vessels” Heart CT preferred)</td>
<td></td>
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</tr>
<tr>
<td>26 A (8)</td>
<td>• Further assessment of complex adult congenital heart disease after confirmation by echocardiogram Footnote – reference ACCF Guideline for Stress Echocardiogram indications #92 and #94</td>
<td></td>
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<tr>
<td><strong>Evaluation of Ventricular Morphology and Systolic Function</strong></td>
<td></td>
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</tr>
<tr>
<td>27 A (7)</td>
<td>• Evaluation of left ventricular function • Following acute MI or in HF patients • Inadequate images from other noninvasive methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 A (7)</td>
<td>• Quantitative evaluation of right ventricular function</td>
<td>TTE 15 A(9)</td>
<td></td>
</tr>
<tr>
<td>29 A (7)</td>
<td>• Assessment of right ventricular morphology • Suspected arrhythmogenic right ventricular dysplasia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 U (5)</td>
<td>• Assessment of myocardial viability • Prior to myocardial</td>
<td>SE 176 A(8)</td>
<td></td>
</tr>
</tbody>
</table>
### ACCF et al. Criteria #
### Heart CT (Indication and Appropriate Use Score)  
### A= Appropriate; U=Uncertain

**INDICATIONS**
(*Refer to Additional Information section)

<table>
<thead>
<tr>
<th>INDICATIONS</th>
<th>Other imaging modality crosswalk, TTE, Stress Echo (SE) and Heart MRI (ACCF et al. Criteria # Indication with Appropriate Use Score)</th>
</tr>
</thead>
</table>
| **revascularization for ischemic left ventricular systolic dysfunction**  
• Other imaging modalities are inadequate or contraindicated | |

### Evaluation of Intra- and Extracardiac Structures

<table>
<thead>
<tr>
<th>#</th>
<th>INDICATIONS</th>
<th>OTHER IMAGING MODALITY CROSSWALK</th>
</tr>
</thead>
</table>
| 31 | 31 A (8)  
• Characterization of native cardiac valves  
• Suspected clinically significant valvular dysfunction  
• Inadequate images from other noninvasive methods | Heart MRI 23 A(8) |
| 32 | 32 A (8)  
• Characterization of prosthetic cardiac valves  
• Suspected clinically significant valvular dysfunction  
• Inadequate images from other noninvasive methods | Heart MRI 23 A(8) |
| 33 | 33 A (8)  
• Evaluation of cardiac mass (suspected tumor or thrombus)  
• Inadequate images from other noninvasive methods | Heart MRI 26 A(9) |
| 34 | 34 A (8)  
• Evaluation of pericardial anatomy | |
| 35 | 35 A (8)  
• Evaluation of pulmonary vein anatomy  
• Prior to radiofrequency ablation for atrial fibrillation | |
| 36 | 36 A (8)  
• Noninvasive coronary vein mapping  
• Prior to placement of biventricular pacemaker | |
| 37 | 37 A (8)  
• Localization of coronary bypass grafts and other retrosternal anatomy*  
• Prior to preoperative chest or cardiac surgery  
(*for “localization of coronary bypass grafts” CCTA preferred and for “other retrosternal anatomy” Heart CT preferred) | |
INDICATIONS FOR HEART CT:
Where Stress Echocardiography (SE) is noted as an appropriate substitute for a Heart CT indication #30 then at least one of the following contraindications to SE must be demonstrated:
- Stress echocardiography is not indicated; OR
- Stress echocardiography has been performed however findings were inadequate, there were technical difficulties with interpretation, or results were discordant with previous clinical data.

OR

- Arrhythmias with Stress Echocardiography - any patient on a type 1C anti-arrhythmic drug (i.e. Flecainide or Propafenone) or considered for treatment with a type 1C anti-arrhythmic drug.

For all other requests, the patient must meet ACCF/ASNC Appropriateness criteria for indications (score 4-9) above.

INDICATIONS IN ACC GUIDELINES WITH “INAPPROPRIATE” DESIGNATION:

- Patient meets ACCF/ASNC Appropriateness Use Score for inappropriate indications (median score 1-3) noted below OR one or more of the following:
  - For same imaging tests less than six weeks apart unless specific guideline criteria states otherwise.
  - For different imaging tests, such as CT and MRI, of same anatomical structure less than six weeks apart without high level review to evaluate for medical necessity.
  - For re-imaging of repeat or poor quality studies.
  - For imaging of pediatric patients twelve years old and younger under prospective authorizations.
- Contraindications - There is insufficient data to support the routine use of Heart CT for the following:
  - As the first test in evaluating symptomatic patients (e.g. chest pain)
  - To evaluate chest pain in an intermediate or high risk patient when a stress test (exercise treadmill, stress echo, MPI, cardiac MRI, cardiac PET) is clearly positive or negative.
  - Preoperative assessment for non-cardiac, nonvascular surgery
  - Preoperative imaging prior to robotic surgery (e.g. to visualize the entire aorta)
  - Evaluation of left ventricular function following myocardial infarction or in chronic heart failure.
  - Myocardial perfusion and viability studies.
  - Evaluation of patients with postoperative native or prosthetic cardiac valves who have technically limited echocardiograms, MRI or TEE.
ADDITIONAL INFORMATION RELATED TO HEART CT:

Abbreviations
ACS = acute coronary syndrome
ARVC = arrhythmogenic cardiomyopathy
ARVD = arrhythmogenic right ventricular dysplasia
CABG = coronary artery bypass grafting surgery
CAD = coronary artery disease
CCS = coronary calcium score
CHD = coronary heart disease
CT = computed tomography
CTA = computed tomography angiography
ECG = electrocardiogram
HF = heart failure
MET = estimated metabolic equivalent of exercise
MI = myocardial infarction
MPI = Myocardial Perfusion Imaging or Nuclear Cardiac Imaging
PCI = percutaneous coronary intervention
SE = Stress Echocardiogram
TTE = Transthoracic Echocardiography

ECG–Uninterpretable
Refers to ECGs with resting ST-segment depression (≥0.10 mV), complete LBBB, preexcitation (Wolff-Parkinson-White Syndrome), or paced rhythm.

Acute Coronary Syndrome (ACS):
Patients with an ACS include those whose clinical presentations cover the following range of diagnoses: unstable angina, myocardial infarction without ST-segment elevation (NSTEMI), and myocardial infarction with ST-segment elevation (STEMI).

*Pretest Probability of CAD for Symptomatic (Ischemic Equivalent) Patients:*

- **Typical Angina (Definite):** Defined as 1) substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.
- **Atypical Angina (Probable):** Chest pain or discomfort that lacks 1 of the characteristics of definite or typical angina.
- **Nonanginal Chest Pain:** Chest pain or discomfort that meets 1 or none of the typical angina characteristics.

Once the presence of symptoms (Typical Angina/Atypical Angina/Non angina chest pain/Asymptomatic) is determined, the pretest probabilities of CAD can be calculated from the risk algorithms as follows:

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>Age</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>--------</td>
<td>--------------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>40–49</td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>

- **Very low**: Less than 5% pretest probability of CAD
- **Low**: Less than 10% pretest probability of CAD
- **Intermediate**: Between 10% and 90% pretest probability of CAD
- **High**: Greater than 90% pretest probability of CAD

**Global CAD Risk**:
It is assumed that clinicians will use current standard methods of global risk assessment such as those presented in the National Heart, Lung, and Blood Institute report on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III [ATP III]) (18) or similar national guidelines. CAD risk refers to 10-year risk for any hard cardiac event (e.g., myocardial infarction or CAD death).

- **Low global CAD risk**
  Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CAD risk <10%. However, in women and younger men, low risk may correlate with 10-year absolute CAD risk <6%.

- **Intermediate global CAD risk**
  Defined by the age-specific risk level that is average. In general, moderate risk will correlate with a 10-year absolute CAD risk range of 10% to 20%. Among women and younger age men, an expanded intermediate risk range of 6% to 20% may be appropriate.

- **High global CAD risk**
  Defined by the age-specific risk level that is above average. In general, high risk will correlate with a 10-year absolute CAD risk of >20%. CAD equivalents (e.g., diabetes mellitus, peripheral arterial disease) can also define high risk.

**Perioperative Clinical Risk Predictors**:

- History of ischemic heart disease
- History of compensated or prior heart failure
- History of cerebrovascular disease
- Diabetes mellitus (requiring insulin)
- Renal insufficiency (creatinine >2.0)

**Surgical Risk Categories** *(As defined by the ACC/AHA Guideline Update for Perioperative Cardiovascular Evaluation of Non-Cardiac Surgery)*

- **High-Risk Surgery**—cardiac death or MI greater than 5%
  - Emergent major operations (particularly in the elderly), aortic and peripheral vascular surgery, prolonged surgical procedures associated with large fluid shifts and/or blood loss.
Intermediate-Risk Surgery—cardiac death or MI = 1% to 5%
- Carotid endarterectomy, head and neck surgery, surgery of the chest or abdomen, orthopedic surgery, prostate surgery.

Low-Risk Surgery—cardiac death or MI less than 1%
- Endoscopic procedures, superficial procedures, cataract surgery, breast surgery.

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Intravascular administration of contrast material may be contraindicated in patients who have a documented allergy from prior contrast administration or a history of atopy. Intravascular contrast agents may be contraindicated in patients who have impaired renal function.

Echocardiography – This study remains the best test for initially examining children in the assessment of congenital heart disease. However, if findings are unclear or need confirmation, CT is useful and can often be performed with only mild sedation because of the short acquisition time.

CT and Congenital Heart Disease (CHD) – Many more children with congenital heart disease (CHD) are surviving to adulthood, increasing the need for specialized care and sophisticated imaging. Currently more adults than children have CHD. CT provides 3D anatomic relationship of the blood vessels and chest wall, and depicts cardiovascular anatomic structures. It is used in the evaluation of congenital heart disease in adults, e.g., ventricular septal defect and anomalies of the aortic valve. CT is also used increasingly in the evaluation of patients with chest pain, resulting in detection of unsuspected congenital heart disease. CT is useful in the evaluation of children with CHD when findings from echocardiography are unclear or need confirmation.

CT and Cardiac Masses – CT is used to evaluate cardiac masses, describing their size, density and spatial relationship to adjacent structures. Nearly all cardiac tumors are metastases. Primary tumors of the heart are rare and most are benign. Cardiac myxoma is the most common type of primary heart tumor in adults and usually develops in the left atrium. Characteristic features of myxomas that can be assessed accurately on CT include location in the left atrium, lobulated margin, inhomogeneous content, and a CT attenuation value lower that that of blood. Echocardiography is the method of choice for the diagnosis of cardiac myxoma; CT is used to evaluate a patient with suspected myxoma before surgery. Cardiac tumors generally vary in their morphology and CT assessment may be limited. MRI may be needed for further evaluation.

CT and Pericardial Disease – CT is used in the evaluation of pericardial conditions. Echocardiography is most often used in the initial examination of pericardial disease, but has disadvantages when compared with CT which provides a larger field of view than echocardiography. CT also has superior soft-tissue contrast and provides anatomic delineations enabling localization of pericardial masses. Contrast-enhanced CT is sensitive in differentiating restrictive cardiomyopathy from constrictive pericarditis which is caused
most often by cardiac surgery and radiation therapy. CT can depict thickening and calcification of the pericardium, which along with symptoms of physiologic constriction or restriction, may indicate constrictive pericarditis. CT is also used in the evaluation of pericardial masses which are often detected initially with echocardiography. CT can accurately define the site and extent of masses, e.g., cysts, hematomas and neoplasms.

**CT and Radiofrequency Ablation for Atrial Fibrillation** – Atrial fibrillation, an abnormal heart rhythm originating in the atria, is the most common supraventricular arrhythmia in the United States and can be a cause of morbidity. In patients with atrial fibrillation, radiofrequency ablation is used to electrically disconnect the pulmonary veins from the left atrium. Prior to this procedure, CT may be used to define the pulmonary venous anatomy which is commonly variable. Determination of how many pulmonary veins are present and their ostial locations is important to make sure that all the ostia are ablated.
REFERENCES


Reviewed/Approved by Michael Pentecost, MD, Associate Chief Medical Officer